MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2016/2017

EMF3066 – ANTENNA AND PROPAGATION

(MCE & TE)

4TH MARCH 2017
9.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages with 5 Questions only.

2. Attempt **ALL FIVE** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) A short dipole antenna excited with an Alternating Current (AC) of magnitude 100 mA has a length of 1 cm and operates at 1 GHz frequency. Calculate the magnitude of tangential electric field along the bore sight at a distance of 80λ.

Note: Bore sight is the XY-plane if the short dipole antenna lies along the Z-axis.

[7 marks]

(b) The normalized radiation intensity of an antenna is given by:

$$U = \sin\theta \sin\phi$$

The intensity exists only in the region $0 \leq \theta \leq \pi$, $0 \leq \phi \leq \pi$, and it is zero elsewhere.
Find the:

(i) Exact directivity (dimensionless and in dB)

[5 marks]

(ii) Azimuthal and elevation plane half-power beamwidths (in degrees)

[4 marks]

(c) Define the following terms related to antenna radiation pattern:

(i) Major lobe

(ii) First null beamwidth

[4 marks]

Question 2

(a) Figure Q2 (a) below shows two short dipoles spaced a distance d (=λ/2) on the y-axis. The dipoles are aligned along the z-axis. The dipoles are excited with AC currents of similar magnitude and are out of phase by 180°.

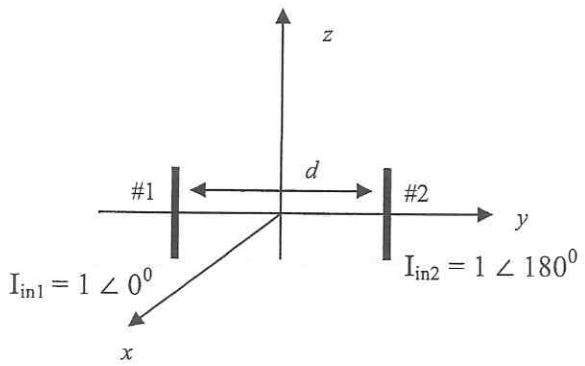

Figure Q2 (a): Array of Two Short Dipole Antennas

Continued...

The radiation pattern (field pattern) for a short dipole is given as cos θ (with θ = 0° at y-axis).

(i) Determine the array factor for the two element array.

[4 marks]

(ii) Determine the radiation pattern by using the pattern multiplication theorem.

[3 marks]

(iii) Determine the location of pattern maximum and minimum and sketch the array patterns for the x-y and y-z planes.

[9 marks]

(b) Explain the effect of increasing the element number, N in an antenna array (with all the other parameters constant).

[4 marks]

Question 3

(a) With the help of a diagram, explain the construction of a Cassegrain reflector antenna. Next, list FOUR (4) advantages of this antenna.

[12 marks]

(b) Explain how a probe feed for a microstrip patch antenna differs from an edge feed, in terms of the feed construction and the structure of the layers, with the help of diagrams.

[8 marks]

Question 4

(a) The environment affects free-space propagation of a radio wave in a number of ways where diffraction is one example. Define diffraction and explain this mechanism.

[6 marks]

(b) An ionospheric layer has a maximum electron density of 5.0×10^{11} electrons per cubic meter. Calculate the maximum frequency of a signal that will be returned back to earth when the angle of incidence is 45°.

[6 marks]

(c) In a very high frequency (VHF) communication, a 100 MHz isotropic transmitter has a transmit power of 25W. Given that the height of the transmitting and receiving antennas are 60 meters and 20 meters respectively, determine the distance up to which line of sight communication is possible and find the field strength at the receiver for this distance.

[8 marks]

Continued...

Question 5

(a) Give FIVE (5) examples of radar applications and their associated frequency bands, based on FCC frequency allocation.

[5 marks]

(b) With the aid of a suitable diagram, derive the Doppler frequency shift for an opening target. Explain all the terms used in the derivation.

[12 marks]

(c) List THREE (3) advantages of Continuous Wave (CW) radar.

[3 marks]

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Appendix A

Physical Constants and Units

Constant	Symbol	Value (mks units)
Speed of light in vacuum	c	3×10^{8} m/s
Electron charge	q	1.602×10^{-19} C
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Permittivity of free space	ε_0	8.8542×10^{-12} F/m
Permeability of free space	μ_0	$4\pi \times 10^{-7}$ N/A^2
Electron volt	eV	1 eV = 1.602×10^{-19} J
Planck's constant	h	6.626×10^{-34} J·s
Electron rest mass	m	9.11×10^{-31} kg
Effective electron mass	m_e	$0.068m$
Effective hole mass	m_h	$0.56m$

End of paper.